LAMINATES FOR ENCAPSULATING DEVICES

FIELD OF THE INVENTION

The present invention relates to the fabrication of devices. More particularly, the invention relates to packaging of devices.

BACKGROUND OF THE INVENTION

In device fabrication, one or more device layers are formed on a substrate. The layers are sequentially deposited and patterned to create features on the surface of the substrate. The layers can be patterned individually and/or as a combination of layers to form the desired features. The features serve as components that perform the desired functions, creating the device.

One type of device which is of particular interest is a light emitting diode (LED). LEDs can have a variety of applications. For example, a plurality of LED cells or pixels can be formed on a substrate to create a pixelated LED device for use as a display, such as a flat panel display (FPD) for telephones, computer displays, TV screens and the like.

Typically, an LED pixel comprises one or more functional layers sandwiched between two electrodes to form a functional stack. Charge carriers are injected from both electrodes. These charge carriers recombine in the functional layer or layers, causing visible radiation to emit. Recently, significant advances have been made utilizing organic functional layers to form organic light emitting diodes (OLEDs).

OLED pixels are very sensitive to the environment. Exposure to moisture and/or air causes rapid degradation of the OLED, creating reliability problems. Some of the substances used to build the layers are sensitive organic compounds and some reactive metals like Calcium and Magnesium. These materials are extremely susceptible to damage caused by oxidation in the presence of oxygen and/or moisture. Thus, a package which adequately protects the OLED from the environment is needed. Further, the package should be cost effective and conductive to high throughput to reduce the overall manufacturing cost and time.

SUMMARY OF THE INVENTION

The invention relates to packaging of a device. In accordance with the invention, the device is package using a laminate. In one embodiment, laminates are placed on the top and bottom of a device. The laminates are pressed against the device and heated to activate a sealant which causes the laminates to adhere to the device. In one embodiment, the laminate is pressed against the device and heated using rollers.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows an embodiment of the invention;

FIG. **2** shows a laminate for encapsulating an electrical device in accordance with one embodiment of the invention;

FIGS. **3–5** illustrate a process for encapsulating an electrical device; and

FIG. **6** shows an embodiment that includes support posts.

PREFERRED EMBODIMENTS OF THE INVENTION

The invention relates generally to the fabrication of devices. In particular, the invention provides a cost effective package for encapsulating devices, particularly those formed on flexible or thin substrates.

FIG. **1** shows a cross section of a device **110** in accordance with one embodiment of the invention. The device can be, for example, electrical, mechanical, or electromechanical. Microelectromechanical systems (MEMS) are also useful. The device comprises one or more active components formed on a substrate. The active components provide the desired electrical and/or mechanical functions.

To reduce the overall thickness of the device, the active components can be formed on a thin substrate, such as less than 0.3 mm thick. Forming the active components on a thin flexible substrate is also useful to provide a flexible device. The substrate comprises, for example, plastic, polymer, silicon, ceramic, glass, or quartz glass. Other types of substrates, such as semiconductor substrates are also useful. The thin substrate should provide adequate mechanical integrity to support the components during and after processing. Typically, the thin substrates are about 20–300 um.

In one embodiment, the device **110** comprises an electrical device, such as a pixelated OLED device. Terminals or pins (not shown) which enable electrical connections to the active components are provided. OLED devices are described in, for example, U.S. Pat. No. 4,720,432 and Burroughes et. al, Nature 347 (1990) 539, which are herein incorporated by reference for all purposes. The pixels of the OLED device can be arranged to form an FPD. FPDs are used in various consumer electronic products, including cellular phones, cellular smart phones, personal organizers, pagers, advertising panel, touch screen displays, teleconferencing equipment, multimedia equipment, virtual reality products, and display kiosks. In one embodiment, the organic LED device comprises a flexible substrate to provide bending, creating, for example, a flexible FPD.

The OLED pixels are materials formed on a substrate **105**. In one embodiment, the substrate comprises a transparent substrate and serves as the display surface. The substrate is prepared to support a laminate **120**. For example, supports **130** are provided surrounding the OLEDs to support the laminate. The laminate covers the device and hermetically seals the components, protecting them from the environment. The device can also include support posts (shown in FIG. **6**) in the non-active regions to provide support for the laminate. This prevents the laminate from collapsing onto the components and affecting the device's functionality. Support posts are particularly useful for flexible devices. Providing support posts in non-active regions of the device is described in concurrently filed International Patent Application titled "Encapsulation of a Device", PCT International Publication Number WO 01/04963 A1, published Jan. 18, 2001, which is herein incorporated by reference.

One embodiment of a device with support posts is shown in FIG. **6**. Active components **610** include organic LED pixels. An organic LED pixel comprises at least one organic layer **614** between first and second electrodes **612** and **616**. The active components **610** are located on active regions **615** of the substrate **601** and are separated by non-active regions **620**. Support posts **630** are located in the non-active regions **620** of the substrate **601** and in the periphery of the device surrounding the active regions **615**. The support posts **630** can be provided in one, some, or in all the non-active regions **620**. A cap **120**, which in this embodiment is a laminate, is mounted on the support posts **630** to encapsulate the device in order to protect the active components from air and/or moisture. The height of the support posts **630** creates a gap or cavity **618** between the surface of the LED pixels